The EUMETSAT Satellite Application Facility on Land Surface Analysis (LSA SAF)

Product User Manual (PUM)

Normalized Difference Vegetation Index

PRODUCTS: LSA-410 AND LSA-453 (ENDVI10)

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1 Introduction

The Satellite Application Facility (SAF) on Land Surface Analysis (LSA) is part of the SAF Network, a set of specialized development and processing centers, serving as EUMETSAT (European organization for the Exploitation of Meteorological Satellites) distributed Applications Ground Segment. The SAF network complements the product-oriented activities at the EUMETSAT Central Facility in Darmstadt. The main purpose of the LSA SAF is to take full advantage of remotely sensed data, particularly those available from **EUMETSAT** sensors, to measure **land surface** variables, which will find primarily applications in meteorology (http://landsaf.ipma.pt/).

The EUMETSAT Polar System (EPS) is Europe's first polar orbiting operational meteorological satellite and the European contribution to a joint polar system with the U.S. EUMETSAT will have the operational responsibility for the "morning orbit" with Meteorological-Operational (MetOp) satellites, the first of which was successfully launched on October 19, 2006. Despite the wide range of sensors on-board MetOp (http://www.eumetsat.int/), most LSA SAF parameters make use of the Advanced Very High Resolution Radiometer (AVHRR) and, to a lesser extent, of the Advanced Scatterometer (ASCAT).

The Metop-AVHRR S10 ("ENDVI10") are near-global, 10-daily composite images which are synthesized from the "best available" observations registered in the course of every "dekad" by the orbiting earth observation system Metop-AVHRR, A year composite of 2009 is shown in Figure 1.

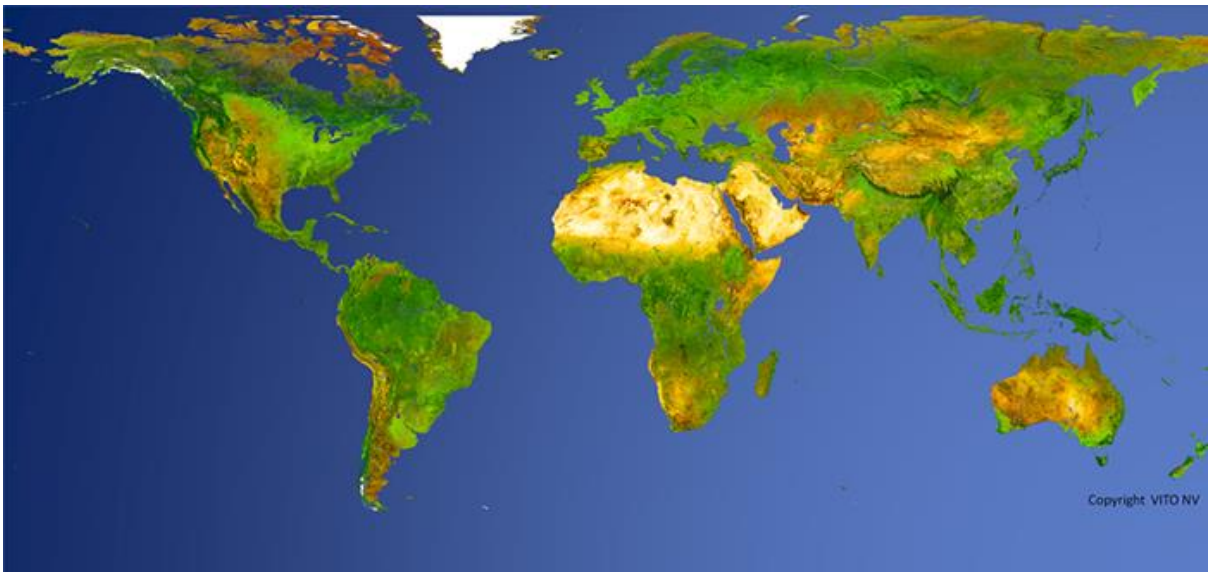


Figure 1 – ENDVI10 product example.

On behalf of the JRC-MARS program of EC, VITO has developed a processing chain for the treatment of NOAA-AVHRR data over Europe. Individual tracks/orbits are ingested, corrected in different steps (calibration, geometric correction, atmospheric correction, cloud/snow labeling) and then composited to 10-daily "Synthesis" images (S10). With this chain all the daytime-observed NOAA data registered since 1981 were treated by different stations in Europe. Recently the procedures were adapted for AVHRR/Metop level 1b data. The resulting S10-composites from

METOP-AVHRR are very comparable with the ones delivered by VITO's SPOT-VEGETATION processing chain: 1km resolution, near-global coverage, frequency of 10 days ("dekad") and similar spectral contents (RED, NIR, SWIR - no BLUE but two thermal bands). In addition to the basic information layers (surface reflectances, angles of the sun/view geometry, status map, etc.), the decadal composites also comprise two "value-added" image layers: NDVI and accompanying LST (Land Surface Temperature).

The Metop-AVHRR S10 is operated in the LSA SAF System II at VITO. ENDVI10 is available as a Climate Data Record (LSA-453) starting in March 2007 and an Interim Climate Data Record (LSA-410) performing continuous updates in Near Real Time of LSA-453. In both cases, ENDVI10 consists of composites representing a Normalized Difference Vegetation Index and are distributed together with a set of ancillary dataset layers (surface reflectances, sun and view angles, quality indicators). The product and ancillary dataset layers described in this document refer to both LSA SAF products: the ENDVI10 Climate Data Record (LSA-453) and ENDVI10 Interim Data Record (LSA-410). The Land Surface Temperature ancillary layer is added on courtesy of VITO, whereof EUMETSAT does not take any liability, responsibility and ownership. The products can be acquired from http://www.metops10.vito.be/index.html.

This document is one of the product manuals dedicated to LSA SAF users. The algorithm and the main characteristics of the vegetation indices (NDVI and accompanying LST) generated by the LSA SAF from AVHRR data system are described in the following sections. The characteristics of AVHRR based vegetation indices provided by the LSA SAF are described in Table 1. Further details on the LSA SAF product requirements may be found in the Product Requirements Document (PRD) available at the LSA SAF website http://landsaf.ipma.pt).

Table 1- Product Requirements for ENDVI, in terms of area coverage, resolution and accuracy.

Product Name	Product Identifier	Coverage	Resolution		Accuracy		
			Temporal	Spatial	Threshold	Target	Optimal
ENDVI10	LSA-453 LSA-410	Global	10-daily	1km	R>0.80	R>0.90	R>0.95

where R = coefficient of determination.

2 Algorithm

2.1 Introduction

The European Metop satellites were conceived by ESA/EUMETSAT to complement the geostationary METEOSATs. In this way they are analogue to the North-American NOAA-platforms which accompany the geostationary GOES-East and -West satellites. Since mid-2007, Metop thus occupies the "morning orbit" while NOAA assumes the "noon orbit": the local solar time of the overpasses is around 9h30' for Metop and 14h for NOAA. Both platforms carry the same AVHRR instrument which scans the full earth surface at ±1km resolution in five spectral bands: RED, NIR, SWIR, TIR1, TIR2. During the night the SWIR-band is switched to MIR, but the ENDVI10 only deal with daytime registrations.

Compared to NOAA, the Metop-AVHRR has been enhanced in three ways: the platform is perfectly stabilized which guarantees an optimal geo-correction of the imagery, all registered 1km data are stored on board and tunneled via the antenna of Svalbard (Sweden) to the central processing center of EUMETSAT (Germany), and the latter performs the most crucial enhancement steps (rectification, calibration, cloud/snow detection) and broadcasts the results in near real-time via its EUMETCast system.

The 1km resolution image data registered all over the globe by METOP-AVHRR are systematically captured by the antenna in Svalbard (Norway) and further tunneled through EUMETSAT (Germany). EUMETSAT immediately applies some crucial pre-processing steps: the raw observations are calibrated and transformed into top-of-atmosphere radiances (TOA), accurate “Lon/Lat-planes” are added with the geographical position of each pixel in the raw segment, and also a mask is added indicating the status of each observation (clear, cloud, snow). The resulting data stream is cut into segments of 3 minutes (1080 scanlines) which are distributed in near-real time via the EUMETCast broadcasting system in the form of EPS-formatted Level1B-files. EUMETSAT operates at the time of writing two METOP platforms, known as METOP-A and METOP-B.

The AVHRR-3 sensor on board of METOP registers in five spectral bands, as shown in Table 2. During the day band 3 operates in the SWIR (3A), during the night it is switched to MIR (3B).

Band nr.	Bandwidth(µm)	Spectral domain	Band abbreviation
1	0.58 - 0.68	Shortwave	VIS (visual) or RED
2	0.725 - 1.00	Shortwave	NIR (near infrared)
3A	1.58 - 1.64	Shortwave	SWIR (shortwave infrared)
3B	3.55 - 3.93	Middle infrared	MIR
4	10.3 - 11.3	Longwave thermal infrared	TIR_4
5	11.5 - 12.5	Longwave thermal infrared	TIR_5

Table 2 : METOP-AVHRR spectral bands

The Level1b files always provide the longitude and latitude on the WGS84 geodetical datum for a subsample of pixels. These "Lon/Lat-planes" are needed for the mapping of the raw images towards a geographical projection system.

2.2 Segment Processing

VITO ingests all the METOP EPS Level1b files received through its EUMETCast reception stations. However, for the production of the ENDVI10 only the daytime segments are used (hence band 3 is always SWIR). Each individual segment is then treated as follows:

- ***Segment selection***:
  The continuous data feed comprises all kinds of METOP-AVHRR imagery, registered over land and sea, during the day and the night. But as the focus is on global vegetation monitoring, only the daytime segments with at least some land pixels are retained for further processing. In line with the VGT-S10, no further attempts are made to process the sea pixels. And the elimination of the night time registrations implies that band 3 always corresponds with the SWIR (B3A).

- ***Spatial - Remap***:
  Using the mentioned Lon/Lat-planes, included by EUMETSAT in the Level1b, and a "nearest neighbour" resampling scheme, the five spectral bands of AVHRR are converted to the WGS84 Geographical Lon/Lat system with the same framing and resolution as used for SPOT-VGT (pixel size of 1°/112 ≈ 1 km along a great circle.

- ***Spatial - Angles***:

  Similar images are computed providing for each pixel the angular position (zenith/azimuth) of the sun and the sensor at the moment of the registration.

- ***Spectral - Shortwave***:

  The on-board registered radiances are converted into surface reflectance factors by means of the SMAC algorithm [Rahman et al, 1994] which removes (at least partially) the unwanted atmospheric and angular impacts on the ground signal. The SMAC-coefficients for METOP's three shortwave channels (RED, NIR, SWIR) were computed on behalf of the MARS-project [Berthelot et al, 2008]. They are also made available via CESBIO's SMAC-website (http://www.cesbio.ups-tlse.fr/fr/smac.htm). In addition to these band-specific coefficients, SMAC also needs the input of the atmospherical state at registration time, in terms of water vapour, aerosol load and ozone content. For the assessment of these three atmospheric state variables, the same approach is followed as for SPOT-VGT: for aerosols and ozone only climatologic values are used (long term monthly averages), but for water vapour more precise data are acquired from ECMWF, i.e. global water vapour maps with a spatial resolution of 0.5° and a renewal frequency of six hours (four water vapour images per day).

  After the atmospheric correction, the Normalised Difference Vegetation Index (NDVI) is computed from the surface reflectances: NDVI = (NIR-RED)/(NIR+RED).

- ***Spectral - Longwave***:

  Land surface temperatures (LST) are derived, separately for land and sea pixels, from the two TIR brightness temperatures using the split window technique [Coll and Caselles, 1997], which also requires the input of water vapour and TIR emissivities. For water vapour, the same six-hourly ECMWF data are used as for SMAC. The TIR emissivities of the land pixels are assessed via a simple linear equation from their NDVI.

- ***Quality - Masking***:

  Each pixel's observational state is expressed via subsequent 0/1-switches in a bitmap image. This "status mask" classifies each pixel according to criteria such as: land↔sea, and clear↔cloud↔snow/ice. While the GLC2000 map [Bartholomé et al, 2005] is used to separate land from sea pixels, the distinction between "clear↔cloud↔snow/ice" is fully based on the results of the cloud/snow detection added by EUMETSAT in the Level1b-files [EUMETSAT, 2004].

2.3 Synthesis Processing

The final ten-daily composites (S10) are created in a similar way as for SPOT-VGT:

- ***Spatial aspects***:

  The composite images follow the same map system as the corrected segments, i.e. WGS84 Geographical Lon/Lat with a resolution of 1°/112. But while the segments only cover limited zones, the S10-composites always extend over the same near-global area, ranging from -180° to +180° in longitude and from -56° to +75° in latitude (40 320 columns x 14 673 lines). As for SPOT-VGT, the composites only contain information for the land pixels. All the water pixels are flagged with unique missing values codes.

- ***Temporal aspects***:

  Every month is divided in three "dekads". The first two always comprise ten days (1-10, 11-20), the third one has variable length as it runs from day 21 until the end of the month. The procedure starts with the selection of all segments registered within the concerned dekad and overlapping at least partially with the mentioned target zone.

- ***Spectral aspects***:

  In general, for each land pixel in the composite, different observations are available, from different segments or registration dates. The compositing selects the "best available" observation and transfers all its components (reflectances, temperatures, angles, status, ...) to the corresponding layers in the S10 synthesis. A classification action is performed, as explained further below. After the classification, the best available group is found. If it contains only one observation, this will be the "best" one. If there are more, the one with the highest NDVI is selected. This method favours the near-nadir views and suppresses the observations which are still partly affected by clouds, snow and water (which all have low NDVI).

- ***Quality Control***:

  Scenes of NOAA-AVHRR are often affected by radiometric errors (stripes, waves) or geometrical shifts, especially when a platform reaches its nominal lifetime. Hence, after the pre-processing each individual segment is visually checked by an operator who identifies and rejects the bad scenes. Without this measure, the bad segments can spoil the quality of the final composites. But after one year of similar checks on the AVHRR data of METOP, no such errors could be detected. So as an alternative, we now only check the daily global composites, which are produced as well in the background. This requires less time and is as effective as checking hundreds of individual segments (480 per day).

The compositing is a crucial step. Whereas the individual segments contain a lot of clouds and occupy different and scattered areas, the final ten-daily composites are better "filled", less contaminated by clouds and they always cover the full area of the “target zone”, in this case the major part of the globe. The global S10-composites derived from METOP-AVHRR have the same spatial characteristics as the S10 of SPOT-VGT – both can even directly be superimposed. As mentioned, all sea pixels are flagged and information is only provided for the land pixels.

The compositing rule is a classical “Maximum NDVI” with constraints on the observation status and the registration geometry. In practice, for each pixel the available observations are first classified as follows (Θ_s=*sun zenith angle,* Θ_v=*view zenith angle)* as shown in Table 3.

OBSERVATION STATUS	REGISTRATION GEOMETRY		
	BAD θ_s>75° or θ_v>45	ACCEPTABLE θ_s<75° and θ_v>40	GOOD θ_s<75° and θ_v<40
Cloud	Not used	C2	C1
Snow/Ice	Not used	B2	B1
Clear	Not used	A2	A1

Table 3 : Compositing rule

All observations in the BAD category are immediately discarded. The remaining ones (if any) are grouped in six classes with the following hierarchy: A1>A2>B1>B2>C1>C2. Then the highest non-empty class is searched. If it contains only one observation, that one is selected, else it will be the one with the highest NDVI (which promotes the cloud and snow free data). If a pixel has no GOOD or ACCEPTABLE observations, its position in the composite is flagged with special codes in all spectral layers. But in all other cases (at least one acceptable measurement), the ENDVI10-composite will contain the values of the best observation (reflectances, angles, etc.), while its nature (clear, cloudy,...) is expressed via the ENDVI10 Status Map.

3 Product Description

3.1 Image format and naming convention

The ENDVI10 LSA SAF product follows the following naming standard:

METOP_AVHRR_*YYYYMMDD*_S10_*www_vvv.ee*>

where

- *YYYYMMDD* = start date of the concerned dekad. YYYY, MM, DD denote the year, the month, the day. DD can only be 01, 11 or 21, as being the start of the 10-daily period.
- *www* = the label of the selected geographical window (see paragraph 3.4).
- *vvv* = the label of the concerned image layer (see paragraph 0).
- *eee* = the filename extension (IMG, HDR, TIF or XML).

The ENDVI10 products are distributed in zip archives. The archive uses a simple name convention:

***YYYYMMDD_www*.zip**

with the same convention as described above. Each zip archive contains 26 files:

- twelve image layers represented by an image and the corresponding header,
- one xml file containing the metadata conform to INSPIRE metadata guidelines version 1.2. INSPIRE is a European metadata format description providing rules to use the IOS19115 standard. Note the xml file does not have a label representing the image layer, hence no *vvv*. The indication whether the data source is METOP-A or METOP-B is comprised in the metadata file in the element <identificationInfo>/<aggregationInfo>. The source is indicated as either METOP_A or METOP_B representing the source of the L1b input segments.
- one quicklook in a black&white geo-tiff format. The quicklook is sub-sampled to 25% in both horizontal and vertical direction from the NDVI band.

The image layers are provided in "flat binary" format without header/trailer bytes. "Flat" means that each layer of a certain composite is stored in a separate image file. These files have the fixed extension *.IMG. Because all layers have the byte data type (1 pixel = 1 byte), the total number of bytes in each image is equal to the number of pixels (see Npix in Table 4). This type of imagery can be easily imported in any standard software for image processing.

Associated to each image file is a small ASCII-formatted annotation file, which uses the same filename as the image but extension *.HDR. It provides all the basic ancillary information to import the imagery directly into the ENVI software. Similar annotation files can easily be created for other packages. Figure 2 depicts an example of the HDR of the NDVI image of EUR-window extracted from the ENDVI10 of the second dekad of February 2010. The sequence "1.5, 1.5, -11, 75" in "map info" specifies that the center of the top-left pixel (Col=1.5, Rec=1.5) is located at the geographical position with Lon=-11°, Lat=75°.

```
ENVI
description = {METOP-AVHRR, 10-daily synthesis, 20100211-20100220, NDVI,
processing by VITO-Belgium}
samples = 8176
lines = 5600
bands = 1
file type = ENVI Standard
data type = 1
sensor type = METOP-AVHRR
map info = {Geographic Lat/Lon, 1.5, 1.5, -11, 75, 0.0089285714,
0.0089285714, WGS-84, units=Degrees}
```

Figure 2 : Example contents of the annotation file METOP-AVHRR_20100211_S10_EUR_NDV.hdr

3.2 Temporal characteristics

Every month is divided in three "dekads". The first two always comprise ten days (1-10, 11-20), the third one has variable length as it runs from day 21 until the end of the month.

The distinction between "days" is based on UT/GMT criteria. And every "dekad" a new ENDVI10 is generated. Although Metop-AVHRR became operational around mid-2007, the ENDVI10 time series distributed by VITO only starts in January 2008. The objective is to deliver each new ENDVI10 with a maximum delay of three days, i.e. at the latest on days 03/13/23.

3.3 Spectral characteristics

Each ENDVI10 composite comprises twelve separate image layers, whose characteristics are listed in Table 4. All layers have data type “8-bit, unsigned byte”, so the digital values V in the images vary (potentially) between 0 and 255.

IMAGE	Physical Values Y			Scaling	Digital Values V	
VVV	**CONTENT**	**UNIT**	**$Y_{lo} \rightarrow Y_{hi}$**	**Y = A + B*V**	**$V_{lo} \rightarrow V_{hi}$**	**V_{flag}**
SR1	$R_{s,RED}$	%	0 → 62.50	Y=0.250*V	0 → 250	255
SR2	$R_{s,NIR}$	%	0 → 83.33	Y=0.333*V	0 → 250	255
SR3	$R_{s,SWIR}$	%	0 → 62.50	Y=0.250*V	0 → 250	255
NDV	NDVI	-	-0.08 → 0.92	Y=-0.08 + 0.004*V	0 → 250	255
LST	Land surface temperature	°C	-50 → 75	Y=-50 + 0.5*V	0 → 250	255
SZA	Sun Zenith Angle	degrees	0 → 125	Y=0.500*V	0 → 250	255
VZA	View Zenith Angle	degrees	0 → 125	Y=0.500*V	0 → 250	255
SAA	Sun Azimuth Angle	degrees	0 → 360	Y=1.500*V	0 → 240	255
VAA	View Azimuth Angle	degrees	0 → 360	Y=1.500*V	0 → 240	255
TCO	Nr. of Clear observations	-	1 → 255	Y=V	1 → 255	0
DAY	Day in dekad	-	1 → 11	Y=V	1 → 11	0
STM	Status Map	-	bit-interpretation (see table below)		1 → 255	0

Table 4 - Image layers of ENDVI10

- NIR=near infrared, SWIR=shortwave infrared.
- R_s=atmospherically corrected "surface" reflectance, NDVI=Normalized Difference Vegetation Index=$(R_{s,NIR}-R_{s,RED})/ (R_{s,NIR}+R_{s,RED})$.
- V=digital value as indicated in the image, Y=physical meaning.
- V_{lo}-V_{hi}=Significant V-range. The scaling only holds for this range. Values beyond V_{lo}-V_{hi} are flags.
- V_{flag}: Per image, there is only one flag to indicate all "aberrant" states (Sea, NoData, NoValidData, Error). The Status Map image provides more information.

Bit-interpretation of the Status Map (Bit7=Most Significant Bit):

Decimal	128	64	32	16	8	4	2	1
Bit-Value	**Bit7**	**Bit6**	**Bit5**	**Bit4**	**Bit3**	**Bit2**	**Bit1**	**Bit0**
1	Land	ValidObs	never	never	Good	CloudORshadow	Cloud	Snow
0	Sea	NoValidObs	always	always	Acceptable	none of these	Cloudfree	NoSnow

Table 5 - Status Map bits

- Bits 4 and 5 are unused and always 0.
- No cloud shadow detection applied, hence always bit2=bit1
- The compositor classifies each pixel's observations in three categories depending on the sun and view zenith angles: "good", "acceptable" and "bad". The last group is definitely withdrawn, but in the absence of "good" observations "acceptable" ones may creep into the composites. This is indicated by bit3.

Sea pixels can be easily recognized because all bits are 0 (thus also the decimal value is zero). Land pixels with at least one cloud/snow-free observation have decimal value 200 (128+64+8) or 192 (128+64, when bit3=0).

3.4 Spatial characteristics

In a spatial sense, the near-global ENDVI10 are identical to (and congruent with) the ones of SPOT-VEGETATION:

Geodetical datum	WGS84
Projection	Unprojected Geographic Lon/Lat
Resolution	ΔLon=ΔLat=1°/112=0.00892857 (± 1 km along a great circle)
Centre of edge pixels	LON_{min}: -180° → LON_{max}+179.991071° LAT_{min}: -56° → LAT_{max}+75°
Ncol / Nrec / Npix	40 320 / 14 673 / 591 615 360

Table 6 - Spatial overview of ENDVI10

However, the near-global imagery is not distributed as such. Users can only select one of the ten pre-defined “windows” listed in Table 7. These windows are the same as used for the free distribution of SPOT VEGETATION products.

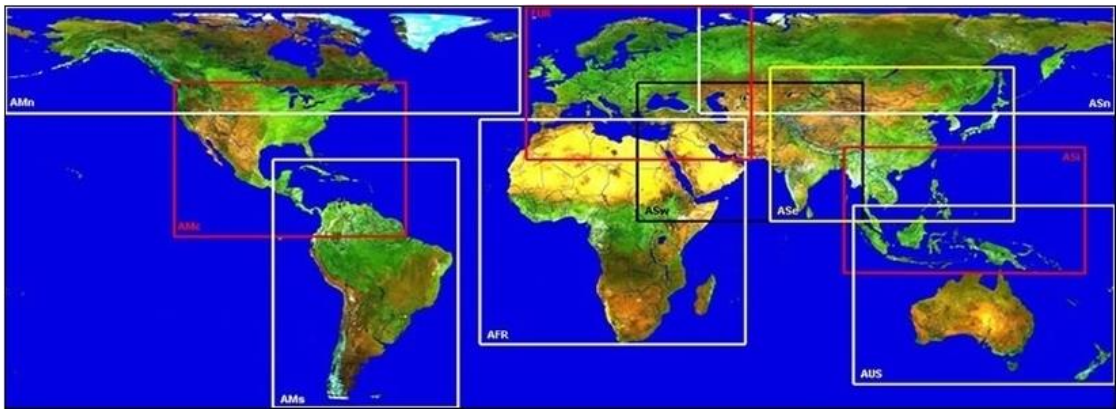


Figure 3 - Spatial windows

www	WINDOW	LON_{min}	LON_{max}	LAT_{min}	LAT_{max}	N_{col}	N_{rec}	N_{pix}
AMn	North America	-180	-13	40	75	18704	3920	73 319 680
AMc	Central America	-125	-50	0	50	8400	5600	47 040 000
AMs	South America	-93	-33	-56	25	6720	9072	60 963 840
EUR	Europe	-11	62	25	75	8176	5600	45 785 600
AFR	Africa	-26	60	-35	38	9632	8176	78 751 232
ASw	Asia West	25	98	5	50	8176	5040	41 207 040
ASn	Asia North	45	180	40	75	15120	3920	59 270 400
ASe	Asia East	68	147	5	55	8848	5600	49 548 800
ASi	Asian Islands	92	170	-12	29	8736	4592	40 115 712
AUS	Australasia	95	180	-48	10	9520	6496	61 841 920

Table 7 - Spatial windows

The listed LON/LAT-values indicate the geographical longitude and latitude of the centre of the edge pixels in each window. 'Ncol' and 'Nrec' are the number of columns and rows in each window and 'Npix' is the total number of pixels (Npix = Nrec x Ncol).

4 Data Access

4.1 Introduction

The ENDVI10 products are freely available without limitations for non-commercial use, and provided under copyright of EUMETSAT. But when they are used for reports, publications or similar, please mention the reference: "*by courtesy of the LSA SAF project, produced by VITO*" and inform us (helpdesk@metopS10.vito.be) for which purpose they are used.

The ENDVI10 products can be accessed through the LSA SAF website (http://landsaf.ipma.pt/), see Figure 4 or directly through a specific product website (http://www.metops10.vito.be/index.html).

The ENDVI10 products can be ordered via the on-line catalogue and/or via subscription, through the link http://metops10.vito.be/etop-s10_pages/gotocatalogue.html, as shown in Figure 5. Selections can be made in time (*e.g.* the 36 dekads of 2009) and in space (*e.g.* one or more of the ten pre-defined windows), but not in a thematic sense (*e.g.* only NDVI and LST). Each individual composite thus always comprises all of the twelve constituent images (see 3.3). The ENDVI10 products are always delivered in ZIP-form.

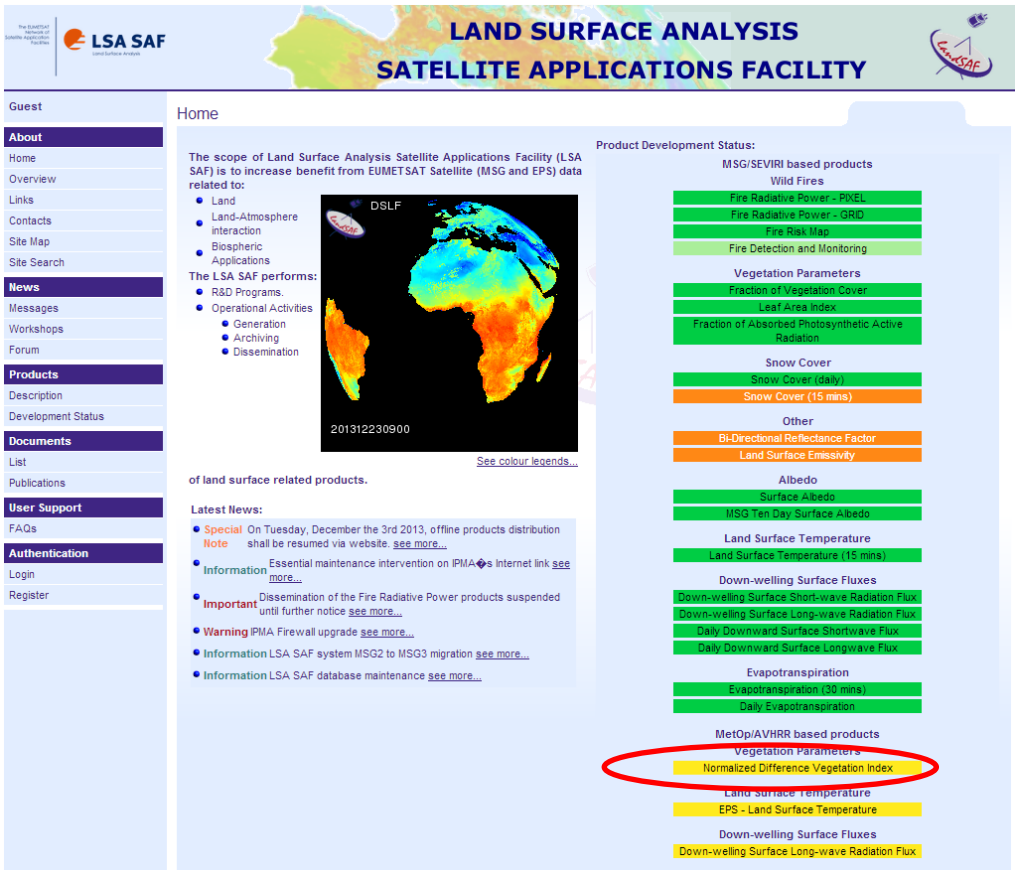
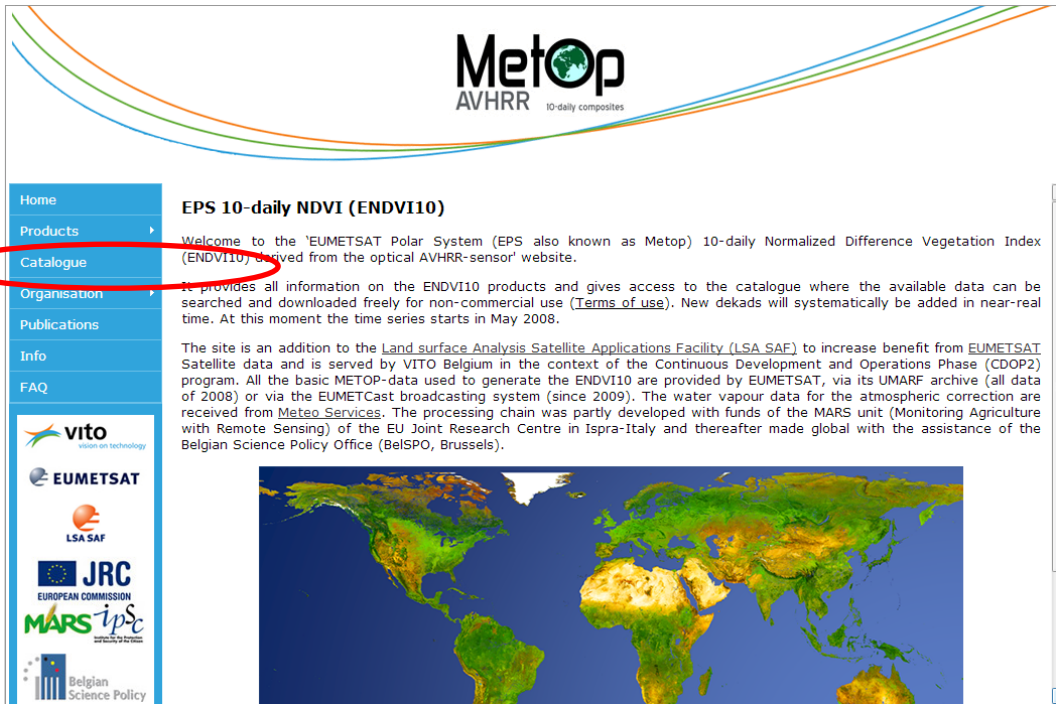


Figure 4 : LSA-SAF ENDVI10 home


MetOp
AVHRR
10-daily composites
Home
Products
Catalogue
Organisation
Publications
Info
FAQ
EPS 10-daily NDVI (ENDVI10)
Welcome to the 'EUMETSAT Polar System (EPS also known as Metop) 10-daily Normalized Difference Vegetation Index (ENDVI10) derived from the optical AVHRR-sensor' website.
It provides all information on the ENDVI10 products and gives access to the catalogue where the available data can be searched and downloaded freely for non-commercial use (Terms of use). New dekads will systematically be added in near-real time. At this moment the time series starts in May 2008.
The site is an addition to the Land surface Analysis Satellite Applications Facility (LSA SAF) to increase benefit from EUMETSAT Satellite data and is served by VITO Belgium in the context of the Continuous Development and Operations Phase (CDOP2) program. All the basic METOP-data used to generate the ENDVI10 are provided by EUMETSAT, via its UMARF archive (all data of 2008) or via the EUMETCast broadcasting system (since 2009). The water vapour data for the atmospheric correction are received from Meteo Services. The processing chain was partly developed with funds of the MARS unit (Monitoring Agriculture with Remote Sensing) of the EU Joint Research Centre in Ispra-Italy and thereafter made global with the assistance of the Belgian Science Policy Office (BelSPO, Brussels).
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LSA SAF
JRC
EUROPEAN COMMISSION
MARS
Belgian Science Policy

Figure 5 - Data Access link

The Catalogue refers to a product distribution facility which provides access to several datasets provided by VITO, amongst them is the ENDVI10 product, see Figure 6.

Figure 6 : ENDVI10 Product Catalogue

4.2 Data Catalogue Discover and Order

The catalogue can be consulted to discover and order available products online. Specific queries can be defined shown in Figure 7.

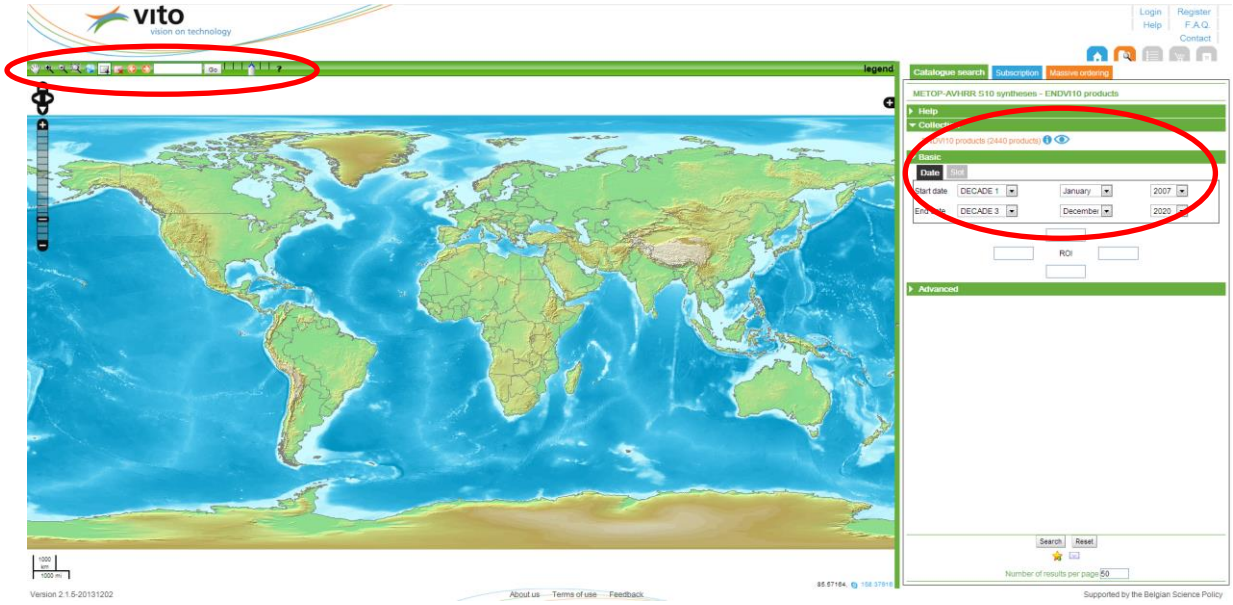

Figure 7 - Product discovery

- A time interval can be specified via the fields 'Start Date' and 'End Date'.
- One of the ten pre-defined windows can be selected by activating the "Draw region of interest" command (icon in top left area). Clicking on the "Search" button then shows the window(s) covering this region. Some AOIs may only fall in one window (*e.g.* Canada in *www*=AMn), others may even be covered by three different windows (*e.g.* Iraq in *www*=ASw, EUR and AFR).

After submitting the query by means of the 'search' button, result pages are shown with an overview of the matching products.

User must be registered before downloading data and need to be logged in before the actual order can be set.

As soon as the products are ready for download over FTP, you will receive an e-mail. Please notice that you can use the same userId/password to download the products from the FTP-server, as the one you use to log on to the catalogue.

4.3 Data Catalogue subscribe and Massive orders

If you are interested in getting the latest ENDVI10 products in near-real time via FTP, you can use the subscribe button to configure your subscription. If you are interesting in getting the full product archive through FTP, you can use the massive order button to configure your order, see Figure **8**.

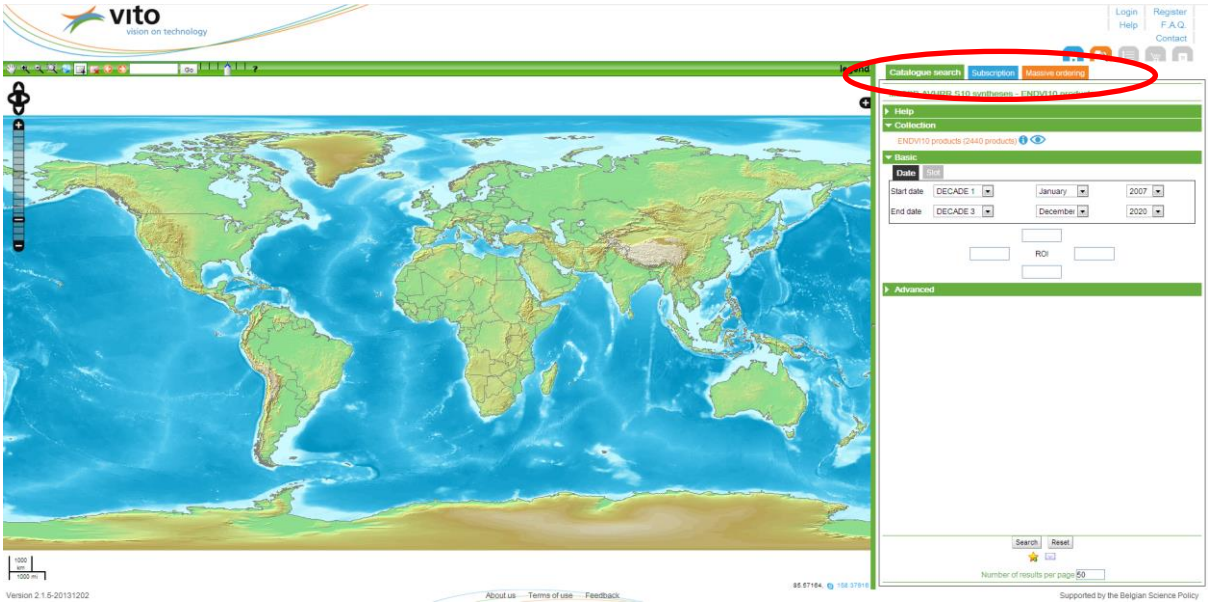

Figure 8 : ENDVI10 subscriptions and massive orders

4.4 Helpdesk

In case of problems or questions, please send an e-mail to the helpdesk (helpdesk@metopS10.vito.be).

5 Validation and Quality Control

The adopted strategy for validation is a comparison between the NDVI of METOP-AVHRR and SPOT-VEGETATION. Both the strength of the agreement and the consistency of this agreement over time was evaluated. The results of the validation can be found in the following report:

- SAF/LAND/VITO/ENDVI_VR/1.0 (February 2013) evaluates the NDVI product

A high, near linear agreement was found between the NDVI of VGT and METOP-AVHRR, and the results were stable over time. The relationship expressed through the geometric mean regression has a slope very close to 1.

A seasonality of the differences exists but is likely caused by a combination of SZA and validity of the atmospheric correction.

The slight non-linearity could be attributed to the differences between the spectral response functions. Other influencing factors, such as viewing geometry were also demonstrated.

Concerning the best metric to evaluate the similarity and the consistency of the agreement over time, it is concluded that the agreement coefficient (AC) is superior to R.

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Appendix A. Acknowledgements

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Appendix B. Glossary

AOI:	Area Of Interest
ATBD:	Algorithm Theoretical Baseline Description
AVHRR:	Advanced Very High Resolution Radiometer
Col:	Column
CVB:	Center for Image Processing, also known as CTIV
Dekad:	10-daily period starting on 01, 11 or 21st of month
EC:	European Commission
ECMWF:	European Center for Mid-term Whether Forecast
ENDVI:	EPS NDVI
ENDVI10:	10-daily EPS-NDVI
EPS:	EUMETSAT Polar System
EUMETSAT:	European Meteorological Satellite Organisation
EUR:	Europe
FTP:	File Transfer Protocol
GLC2000:	Global Land Cover map from year 2000
HDR:	Header
IPMA:	Instituto de Meteorologia (Portugal)
IMG:	Flat binary image
JRC:	Joint Research Center
ENDVI10:	Metop AVHRR 10-daily, same as ENDVI10
NIR:	Near Infrared Radiation
Lat:	Lattitude
Lon:	Longitude
LSA:	Land Surface Analysis
LST:	Land Surface Temperature
MARS:	Monitoring Agriculture through Remote Sensing
METOP:	Meteorological Operational polar satellites of EUMETSAT
MIR:	Medium Infrared
NDVI:	Normalized Difference Vegetation Index
NOAA:	National Oceanic and Atmospheric Administration (USA)
ORR:	Operational Readiness Review
PUM:	Product User Manual
PRD:	Product Requirements Document
R:	Coefficient of determination
Rec:	Record (line)
RED:	Red radiation channel
S10:	10-daily composite starting on 01, 11 or 21st of month
SAF:	Satellite Application Facility
SMAC:	Simplified Method for the Atmospheric Correction
SWIR:	Short Wave Infrared

TOA:	Top of Atmosphere
TOC:	Top of Canopy
TIR:	Thermal Infrared
VGT:	Vegetation sensor on board of SPOT satellites
VITO:	Flemish Institute for Technological Research
WGS:	Wold Geodetic System
ZIP:	File format used for data compression and archiving